Leucaena leucocephala (Lam.) de Wit

Home

Photo

Leguminoseae (Mimosaceae)

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Synonyms

- *Leucaena glauca* (L.) Benth.

Common names

Leucaena, koa haole (Hawai), ipil-ipil (Philippines), Acacia bella rosa, Aroma Blanco, Jumbie bean, Vaivai

Status

Leucaena has long been grown for non-forage uses throughout the tropics (see below). It was developed as a forage in Hawaii (Takahashi and Ripperton 1949) and studied since the thirties. Increased interest and research in the pre-war period led to its development as a fodder in commercial farming in the Australian tropics and in many parts of tropical Asia. Although widespread in Africa the conditions which best suit its growth are also those which favour the tse tse fly. During the 1970s and early 1980s leucaena was known as the 'miracle tree' because of its worldwide success as a long-lived and highly nutritious forage, and its great variety of other uses. It was heavily touted by development agencies in the Asian tropics (Gutteridge and Shelton 1998; Shelton et al. 1995). Following the rapid movement of the leucaena psyllid *Heteropsylla cubana* westward from the Caribbean across the Pacific in 1985/86, however, large areas of previously productive leucaena in the Philippines, Indonesia and Australia have been affected (Shelton et al. 1998) but the pest now seems to be at least partially controlled by natural predation (see Improvement below). It is the best known species of *Leucaena*; there are at least 22 species in the genus. The taxonomy of L*eucaena* is reviewed by Hughes (1998). A Leucaena Genetic Resources Handbook is available from the Oxford Forestry Institute **(Tropical Forestry Paper No. 37)** .

Non-forage uses

Leucaena has long been used as shade in tropical plantation crops and as a live support for climbing crops; for this low seed producing types are preferred. It is also a useful source of poles, timber and firewood. Recently it has been recommended for contour planting in small scale tropical farming systems as a means of soil conservation and fertility maintenance. High seeding types are a nuisance because of the many seedlings that germinate and compete with the crop as well as invading elsewhere, sometimes ousting the indigenous vegetation. There is opportunity to produce seedless triploid hybrids by crossing self-incompatible diploid species such as *L. diversifolia* (2x) with tetraploid species such as *L. leucocephala* Leucaena hedges are useful as windbreaks and firebreaks, the latter due to the suppression of understorey grass growth.

Description

Leucaena leucocephala is a thornless long-lived shrub or tree which may grow to heights of 7- 20 m. Leaves are bipinnate with 6-8 pairs of pinnae bearing 11-23 pairs of leaflets 8-16 mm long. The inflorescence is a cream coloured globular shape which produces a cluster of flat brown pods 13-18 mm long containing 15-30 seeds. Three morphological types are noted by Domergues et al. (1999) a small, bushy Hawaiian type under five metres; a tall Peruvian type with several stems to 15 meters; a Hawaiian giant type with a trunk and great size to 20 metres. The commonest form is the shrubby free-seeding one which tends to be weedy and low yielding (Jones 1979). It was this form which was transported around the world from the 16th to 19th centuries and is now pan-tropical. The true giants have better forage and wood production than the shorter varieties. Examples are K8 and K636.

Environmental adaptation

Leucaena is a very free-seeding, colonizing plant which has spread to a very wide range of sites which are more or less frost-free, and has naturalized itself in many areas, some far outside the tropics. In East Africa it will grow up to about 1 900 meters with growth slowing as altitude increases. It is found as far north as the Punjab and the Himalayan foothills and occasionally in North Africa. It is also seen in many semi-arid areas provided that it can find some soil moisture. To be grown as a forage, however, it needs a long warm, moist growing season: its adaptation as a forage is described below.

Leucaena requires warm temperatures (25-30°C day temperatures) for optimum growth At higher latitudes and at elevated tropical latitudes growth is reduced. (Brewbaker *et al.* 1985) suggest that temperature limitations occur: above 1000 m elevation within 10° latitude of the equator, and above 500 m elevation within the 10-25° latitude zone.

It is not tolerant of even light frosts which cause leaf to be shed (Isarasenee *et al.* 1984). Heavy frosts will kill all aerial growth, although the crowns survive and regrow vigorously in the following summer with multiple branches. Shading reduces growth although it has moderate tolerance of reduced light when compared with other tree legumes (Benjamin *et al.* 1991). Seeds will germinate and establish satisfactorily under established leucaena hedgerows or other tree cover. It has been successfully grown under coconuts in Bali as a support for vanilla.

Leucaena can be found performing well in a wide range of rainfall environments from 650 to 3,000 mm. However, yields are low in dry environments and are believed to increase linearly from 800 to 1,500 mm, other factors being equal (Brewbaker *et al.* 1985).

Leucaena is not tolerant of poorly drained soils, especially during seedling growth, and production can be substantially reduced during periods of waterlogging but, once established, it can survive short periods of excess moisture. It does best on deep, well drained, neutral to calcareous soils; it is often found naturalized on the rocky coralline terraces of Pacific island countries. However, it grows on a wide variety of soil types including mildly acid soils (pH > 5.2). It is well adapted to clay soils and requires good levels of phosphorus and calcium for best growth.

Cultivation and management

Freshly harvested leucaena often has a high degree of hard seed due to an impermeable waxy coat which must be broken before the seed will imbibe water and germinate. Scarification to break this dormancy usually involves treatment with hot water; mechanical scarification is, however a very practical alternative and is recommended for farm use in Queensland by Larsen, (1998). Seed must be inoculated before planting with a suitable *Rhizobium* strain. TAL1145 is recommended. Lime pelleting will protect the *Rhizobium* in very acid soils. *Leuucaena* is partially dependent on endomycorrhizal fungi of the genera *Glomus* and *Microspora.*(Domergues *et al*. 1999)

Leucaena can be sown by seed or planted as 'bare root" seedlings. Large areas are best sown in rows into a fully prepared seed bed, or into cultivated strips in existing grasslands. Seeding rates of 1-2 kg/ha at depths of 2-3 cm are usually recommended in rows 3-10 m apart. Sowings is best done early in the growing season, but when rainfall is reliable using good weed control measures (cultivation and herbicides) to minimize competition; leucaena seedlings are very susceptible to competition in the root zone. Trifluralin (0.5 kg active ingredient (a. i.)/ha) for grass species and Dacthal (8-10 kg a.i./ha) or 2,4-D amine (6 kg a.i./ ha) for broadleaf species are recommended for pre-emergence control of weeds (Brewbaker *et al.* 1985). Fusilade (2 kg a.i./ha) and Basagran (2 kg a.i./ha) are recommended for post-emergence grass and broadleaf weed control respectively. Hand weeding or mechanical cultivation are also effective.

Fertilisation at planting will be necessary on most soils to achieve vigorous seedling growth as many tropical soils are infertile following years of intensive cropping, leaching and erosion from high intensity rains. Leucaena is particularly susceptible to phosphorus deficiency and is dependent on vesicular arbuscular mycorrhizae to extend the capacity of its root system to access immobile nutrients such as phosphorus. In soils low in phosphorus, or low in natural mycorrhizal activity, quite high rates of phosphorus (100 kg P/ha) should be applied. Leucaena is also sensitive to calcium deficiency as this will reduce nodulation. Other nutrients may be necessary if soil tests indicate a deficiency, to ensure vigorous early growth of seedlings. In very acid soils (pH < 5.0), liming is necessary.

Leucaena may be planted as single plants, single hedgerows or multiple hedgerows depending on its use. In the latter case, hedgerows may be closely spaced (75-100 cm) to achieve maximum yield per hectare for cut-and-carry feeding or more widely spaced (3-10 m) for alley cropping or grazing. Intra-row plant spacings of 25-50 cm are adequate. In widely spaced rows for grazing, grasses may be planted between leucaena rows to increase total fodder supply to animals. In Australia, *Panicum maximum* var. *trichoglume*, *Setaria sphacelata, Digitaria decumbens* and *Cenchrus ciliaris* have been successful companion grasses for leucaena.

Seed production

Apart from *Leucaena leucocephala* very little definitive information is available on the seed production of forage tree legumes. *Leucaena leucocephala* is the only species for which seed has been produced in commercial quantities but production is declining in the wake of the psyllid problem. Flowering can occur at any time during the year whenever growing conditions are favourable but will increase under moisture stress and also with the onset of shorter days in the subtropics. It is largely self-fertilized and self-compatible and need only be separated from related species by a few metres to prevent contamination.

Areas with reliable and distinct wet and dry seasons, where the tree legume produces seed during the dry season, are ideal for seed production because of the favourable warm, dry conditions during flowering, pollination and seed development. A fertile, well drained soil will favour good seed production.

Seed yields of up to 3,000 kg/ha were recorded from a small seed production orchard in Hawaii (NFTA 1985). However, the actual yield is much lower due to harvesting problems; pods are often at an inaccessible height and ripen unevenly which means that only a small fraction of the potential seed yield is harvestable at any one time. Repeated hand harvesting can overcome this problem to some extent. In Australia it has been harvested mechanically using overhead booms supported on a frame which knocks ripe pods into a trailer. A mobile thresher and cleaner can be attached to take the seed from the collecting trailer. In 1986/87, over 5 tons of *L. leucocephala* seed were produced for sale in Queensland but this declined to less than 3 tons in 1987/88 following the arrival of the psyllid. Leucaena has a hard seed coat and, once properly dried, can be stored for reasonably long periods without special treatment.

Crop use and grazing management

Animal production on leucaena based pastures is excellent. In southeast Queensland, cattle on leucaena/setaria pastures gained between 310 and 430 kg liveweight per hectare annually, approximately twice that obtained from *Macroptilium atropurpureum* based pastures in the same environment. In low frost environments, leucaena can be held over for feeding in the cool or dry season providing valuable high protein feed during stress periods for grazing ruminants. Under ideal growing conditions under irrigation on the fertile alluvial plains of the Ord River valley, leucaena/*Digitaria decumbens* pastures produced annual liveweight gains of 273 kg/head or 1422 kg/ha at a stocking rate of 6 weaner steers/ha. In central Queensland, on fertile clay soils, cattle are gaining 300 kg liveweight per head per year on leucaena pastures.

The most suitable cutting or grazing intervals to promote high yields vary with environmental factors. In general, longer intervals between defoliation have increased total yield; however, the proportion of inedible wood may also increase leading to a decline in forage quality. At very productive sites, harvest intervals may be 6-8 weeks and up to 12 weeks at less productive locations. Harvest height has less influence on total yield than harvest frequency. Maintenance fertilizers are rarely applied to mature leucaena stands although nutrient deficiency can limit growth.

In Australia, it is recommended that regular heavy grazing of leucaena does not commence until plants are mature and well established. This may take 1-3 years depending on growing conditions. However, light grazing can occur in the first year when plants reach 1.5 m in height. Grazing promotes branching, results in a protective thickening of main stems and can remove flowers and pods which reduce growth rates.

Regular grazing of well established rows of leucaena leads to the development of quite uniform hedgerows. Taller plants or branches are readily broken and reduced in size by hungry animals. In Vanuatu and Papua New Guinea cattle graze in leucaena thickets which may be up to 10 m in height. Cattle graze lower branches and newly emerging seedlings and the upper canopy is kept as a drought reserve. The amount of material available for grazing is reduced in this system of management. Leucaena paddocks are normally rotationally grazed with cattle moved to new areas when most leaf and edible stem have been removed and before serious damage to the wooden framework of the plants has occurred. Appropriate stocking rates vary greatly from less than 1 beast to 1.5 ha in low rainfall environments (750 mm p.a.) up to six beasts/ha in fertile well watered or irrigated stands.

Whether the crop is managed as a hedge, bush, tree or coppice will depend on the system of management and grazing or harvesting which is to be applied. Under small farm conditions leucaena is frequently managed on a cut-and-carry system; this is very demanding in labour which is a constraint to its wider use in Asia (Moog et al. 1998).

Conservation

Leucaena leaves can be dried for use in concentrate feeds. It can be chopped and made into dehydrated meals and in Hawaii a forage harvester and conventional lucerne dryer is used to harvest and dry the material. The crop must, of course, be planted and managed so as to suit the use of a forage harvester. Hand cutting and sun drying is possible in suitable climates where labour is readily available. Dried leucaena is purchased for incorporation into livestock feeds in the Philippines (Moog et al 1998).

Composition

Leucaena is well known for its high nutritional value and for the similarity of its chemical composition with that of alfalfa. Its forage can be low in sodium and iodine, but is high in β -carotene. Tannins in the leaves and especially the stems reduce the digestibility of dry matter and protein but enhance the 'bypass' value of protein.

Digestibility and intake values for leucaena range from 50 to 71% and from 58 to 85 g/kg$^{0.75}$ liveweight respectively (Jones 1979): the lower values were suggested to-be associated with the effects of mimosine on intake when pure diets of leucaena were fed.

The foliage and pods of leucaena contain the toxic amino acid mimosine which may reach 12% of the dry matter in growing tips but is less in young leaves (3-5% of dry matter) (Jones 1979). Although quite toxic to non-ruminant animals, mimosine is broken down by microbes in the rumen to DHP (3 hydroxy-4-(1H)-pyridone) a goitrogen, which is normally broken down further by rumen micro-organisms to non-toxic compounds. (Jones and Jones, 1984) The microbes are naturally present in ruminants in Indonesia and Hawaii and probably other countries of southeast Asia and the Pacific where there has been a long history of ruminant animals grazing naturalized stands.

However, in some countries, notably Australia, Papua New Guinea and perhaps Africa, the appropriate rumen micro-organisms are absent leading to an accumulation of DHP which causes enlargement of the thyroid gland and results in listlessness, loss of appetite, excess saliva production, hair loss and loss of weight. This effect only occurs if leucaena constitutes a high proportion of the animal's diet (>30%) for an extended period. Procedures for the transfer of the appropriate rumen microbes among ruminants have been developed in Australia.

Information on composition and digestibility of Leucaena

Crop improvement

Botanically, leucaena belongs to the family Mimosaceae; it is the best known species of the *Leucaena* genus There are, however, at least 14 other species recognised in the genus. These are *L. collinsii, L. cuspidata, L. diversifolia, L. esculenta, L. greggii, L. lanceolata, L. macrophylla, L. multicapitula, L. retusa, L. pallida, L. pulverulenta, L. salvadorensis, L. shannoni* and *L. trichodes. Leucaena leucocephala* and *L. pallida,* and one subspecies of *L. diversifolia,* are polyploids (104 chromosomes) while all other species are diploid (52 or 56 chromosomes). (Brewbaker, *et al* 1972) *Leucaena leucocephala* and the tetraploid varieties of *L. diversifolia* are self-pollinating while the others are outcrossing. The species may be distinguished on the basis of their tree size, flower colour, leaflet size and pod size. Some authors consider the genus *Leucaena* to be an interbreeding complex capable of producing many interspecific hybrids. For instance, *L. leucocephala* crosses readily with *L. diversifolia* and *L. pallida* producing hybrids from which selection for improved growth form, psyllid resistance and cold tolerance is possible. *Leucaena pallida,* in particular, has excellent seedling vigour and hybridization of this species with *L. leucocephala* has the potential to produce a new highly productive and psyllid resistant Leucaena.

There is some scope for breeding frost tolerance into leucaena. Two- and three-way hybrids of *L. leucocephala* with frost tolerant *L. retusa* show promise (Brewbaker and Sorensson 1990). Kendall *et al.* (1989) suggested that populations of *L. leucocephala* originating from more elevated sites in north-eastern Mexico showed greater frost tolerance than those originating from lowland sites. Leucaena growth is strongly seasonal in the subtropics with low yields in the cool months and the majority of growth occurring in the summer months. For these reasons the best opportunities for developing cool tolerant cultivars lie with hybridization of *L. leucocephala* with *L. diversifolia* and *L. pallida.* These latter two species can be found in elevated sites in Mexico and demonstrate cool tolerance. Hybrids of *L. diversifolia* (4x) x *L. leucocephala* averaged 4.5 m per year height increase in a 2 year period at Waimea, Hawaii at 850 m elevation and mean annual temperature 17°C (Brewbaker and Sorensson 1990).

Pests & diseases

Until relatively recently, there were few pests of leucaena because of the insecticidal properties of mimosine. However, following the rapid movement of the leucaena psyllid *Heteropsylla cubana* westward from the Caribbean across the Pacific in 1985/86, large areas of previously productive leucaena in the Philippines, Indonesia and Australia have been affected. The psyllids or jumping lice are small aphid-like insects adapted to feeding on the young growing shoots of leucaena. Mild infestations cause distortion of leaves whilst heavy infestations result in loss of leaves and attack by secondary moulds which feed on the sticky exudate of psyllids. The psyllid is native to Central America. Bray and Woodroffe (1991) reported that psyllids reduced the production of edible material by 52% and that of stem by 79% in southeast Queensland. There is some scope for biological control from the beetle *Curinus coeruleus,* the parasitic wasp *Psyllaephagus* nr. *rotundiformus* and from resistance in the *leucaena* genus (see papers in Shelton *et al*. 1998).

The moth *Ithome lassula* which damages leucaena inflorescences and the seed beetle *Araecerus levipennis* reduce the production and viability of seed.

A serious disease of seedling leucaena in nurseries is damping-off in moist soils caused by the fungal species *Pythium* or *Rhizoctonia* spp. (Brewbaker *et al.* 1985). This is controlled by good nursery techniques (overwatering promotes the disease) and use of well-drained soil media. The use of fungicides such as Benlate or Captan are also an option.

Links

- *Leucaena leucocephala*: species description
- Project report
- Effect of Leucaena leucocephala and Brassica napus on growth of pigs fed wheat bran diets:article
- Pacific Island Ecosystems at Risk (PIER): *Leucaena leucocephala*
- Agriculture Faculty, Cantho University, Vietnam: article.
- Article on *Leucaena leucocephala* in Spanish
- Intercropping of sesbania (*Sesbania sesban*) and leucaena (*Leucaena leucocephala*) with five annual grasses: abstract
- Propagation of Leucaena leucocephala: article
- Agroforestry Uses of Leucaena leucocephala
- Purdue University: *Leucaena l.*

References

Benjamin, A. *et al.* (1991); Bray, R.A. and Woodroffe, T.D. (1991); Brewbaker, J. L. and Sorensson, C.T. (1990); Brewbaker, J.L. *et al.* (1985); Brewbaker, J.L. *et al.*(1972); Dommergues, Y. E. *et al.* (1999); Gutteridge R. C. and M. Shelton (1998); Hughes C.E. (1998); Isarasenee, A. *et al.* (1984); Jones, R.J. (1979); Jones, R.M. and Jones, RJ. (1984) ; Kendall J. *et al.* (1989); Larsen, P.H. (1998); Moog F.A. *et al.* (1998); NFTA (1985); Shelton, H.M. *et al.*(1995); Shelton H.M. *et al.*(1998); Takahashi, M. and Ripperton, J. C. (1949)